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**SEA OTTER POPULATION
AND TRANSPLANT STUDIES
IN ALASKA, 1959**



SPECIAL SCIENTIFIC REPORT: WILDLIFE No. 48

**UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE**

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IN ALASKA, 1959

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UNITED STATES
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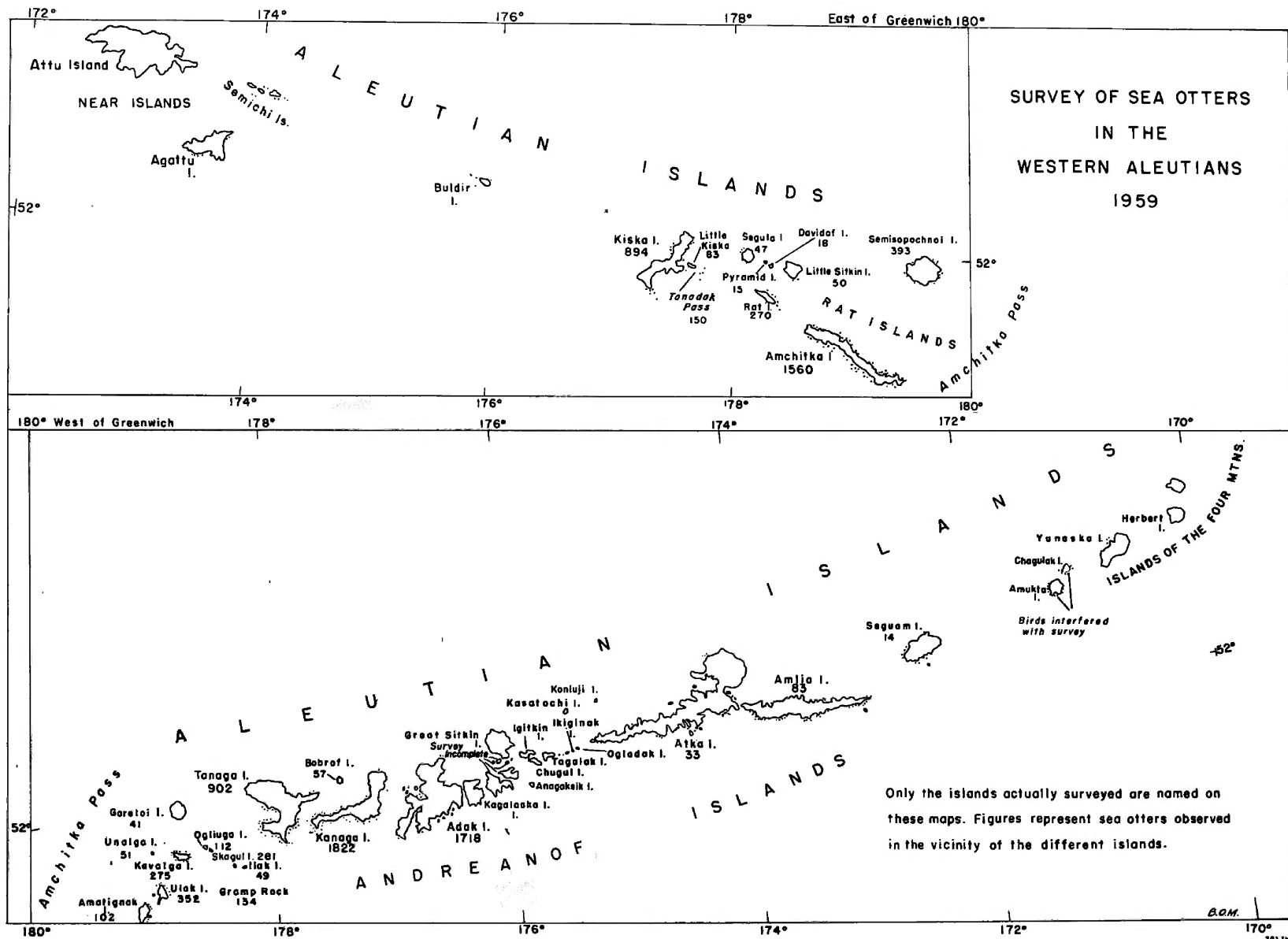
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SEA OTTER POPULATION AND TRANSPLANT STUDIES IN ALASKA, 1959

PART I

AERIAL SURVEY OF WESTERN ALEUTIAN AREA, 1959, and ESTIMATES OF THE SEA OTTER POPULATION OF ALASKA

This report presents the results of our 1959 aerial survey and an evaluation of the survey based on sample boat and shore observations. A discussion of previous population estimates is included, together with our estimate of the present sea otter population in Alaska. Only adult and subadult otters are considered. Pups still with their mothers could not be counted from the air. This aspect of the sea otter population will be discussed in a later report.

Aerial surveys were conducted in the outer (western) islands of the Aleutian Islands National Wildlife Refuge in 1959 to furnish current information on the distribution of sea otters and the approximate size of island populations in this area. Between 19 and 27 May virtually every Aleutian island west of (and including) Herbert Island, in the Islands of Four Mountains, was surveyed.

The FWS R4D Aircraft N701 itinerary was as follows:

Date 1959	Takeoff	Land	Flight hours	Area surveyed
17 May	Anchorage	Adak	8.9	None
18 "	Adak	Amchitka	3.5	Practice counts en route
19 "	(Amchitka (Shemya	Shemya) Amchitka)	9.1	Rat Islands Near Islands
20 "	Amchitka	St. Paul	4.3	(otter transplant)
21 "	St. Paul	Adak	3.6	None (poor weather)
24 "	Adak	Adak	1.0	None (poor weather)
25 "	Adak	Adak	5.1	Andreanof Is. (part)
26 "	Adak	Adak	9.3	Andreanof Is. (part), Delarof Is. and Semisopochnoi
27 "	Adak	King Salmon	10.0	Andreanof Is. (part) and Seguam to Herbert Is. (Is. of Four Mountains)
27 "	King Salmon	Anchorage	2.0	None
Total aircraft hours			56.8	

Personnel included the following:

Theron Smith, FWS Aircraft Supervisor, Pilot.

Jim Tilford, Bureau of Land Management, Co-pilot.

David L. Spencer, FWS Regional Refuge Supervisor, Observer.

Karl W. Kenyon, FWS Biologist, Observer.

Norman J. Wilimovsky, FWS Biologist, Bureau of Commercial Fisheries who accompanied all flights primarily to look for herring concentrations.

METHODS OF SURVEY

Five requirements must be met if a census survey of sea otters by aircraft is to be of value: (1) The pilot of the aircraft must cooperate completely with the observers and must have considerable experience in survey work. Frequent circling back over areas is necessary and the pilot must, by experience, know exactly how to place the observers in position to best see a certain spot. (2) Two observers are essential. They must divide the area to be viewed in half, each counting all otters on his side of the centerline of the aircraft flight path. (3) The observers must have a clear view of all areas directly ahead and on both sides of the aircraft. (4) The observers must be familiar both with aerial survey work and with sea otters. (5) Weather must be nearly calm; an overcast sky is best for observation.

Fortunately, all of these requirements could be met in the May 1959 aerial survey of the outer Aleutian Islands.

When large groups of otters were found, counts were of necessity supplemented by estimates. In such instances each observer made an independent estimate, then a final figure was agreed upon. In all cases both estimates were similar. Groups of more than 100 animals were infrequently seen.

The altitude of flight was sometimes dependent on terrain and wind conditions. For most of the survey an altitude of 300 feet above the water was maintained, but under some conditions it was necessary to go briefly to 500 feet. An airspeed of about 120 knots was maintained.

The advantages and disadvantages of aerial, dory, and shore surveys, as methods of censusing sea otters, are tabulated below.

Aerial surveys

Advantages:

1. Survey is made rapidly, and errors introduced by movements of otters from one area to another are eliminated.
2. Hundreds of miles of otter habitat may be covered in a few hours of flight time.

3. The expense per unit of area covered is low.
4. The distribution and relative magnitude of sea otter populations over a large area are easily and quickly obtained.

Disadvantages:

1. Weather conditions must be ideal; in most Alaska areas, delays caused by bad weather may be considerable.
2. Considerable danger is involved in low flight over water and rugged isolated areas.
3. Only adult and subadult otters can be enumerated; pups with mothers are difficult to see.
4. Otters beneath the surface on food dives are missed because of the rapidity of flight.
5. Sea birds, other sea mammals, and certain species of kelp (Nereocystis) may cause confusion.

Dory surveys

Advantages:

1. Areas may be covered thoroughly, both inshore and offshore, more rapidly than by a shore survey.
2. Food-diving otters usually appear on the surface while in the range of vision from the boat, giving a fairly complete coverage.
3. Pups with mothers are easily seen and counted.

Disadvantages:

1. Much time is necessary to properly cover an extensive area.
2. Changing weather conditions may interrupt surveys, causing inaccuracies in censusing because of movements of otters from one area to another.
3. If large areas are to be covered, the considerable time involved with attendant crew maintenance costs is considerable.
4. The distance of visibility from a boat is limited, necessitating time-consuming inshore and offshore trips along the same coastal area.

Shore surveys

Advantages:

1. Through the use of telescope and binoculars, the most nearly complete coverage of a unit of area is possible at a given time.
2. Counts of adults, subadults, and pups is probably most accurately obtained.
3. Observations additional to population counts may be carried on.
4. Sample counts may be obtained repeatedly from established observation points.

Disadvantages:

1. This is the most time-consuming of methods considered. It is very laborious to count food-diving otters when many are in a limited area.
2. Interruption of observations by changing weather causes the results to be unreliable; movements of otters from exposed areas to more sheltered areas are influenced by weather conditions.
3. Some areas cannot be viewed because offshore rocks limit visibility and rugged precipitous coastal areas are inaccessible to the observer; an unknown number of otters are missed.

Our best estimate of sea otter populations is indicated by considering data obtained by each method. The comprehensive aerial survey's greatest value is that it reveals otter distribution and relative magnitudes of different island populations. At the same time counts are obtained that provide a basis for estimates of total population. In 1959, in 30 hours of survey flight time, an area more than 500 miles in length and containing more than 50 islands was covered. If such a survey had been attempted by boat the undertaking would have required an estimated 2 or 3 years, many times the expense, and we believe, would have yielded less reliable data. At the present apparent rate of otter population spread and increase, parts of a boat survey would be out of date before the operation was completed. Counts made from a dory and from the shore in sample areas furnish data that may be used as a rough check on aerial counts. They also yield other information which cannot be obtained from the air.

RESULTS AND EVALUATION OF THE SURVEY

Dory counts compared with aerial counts

In a sample area 9.5 nautical miles in length along the north coast of Amchitka, bounded by Crown Reefer Point and Ivakin Point, counts were made from a dory on 5 different days (see Appendix A). The number of otters counted in the area varied. The mean of all counts was 157 otters. If the best counts are chosen (surface counts made under the most favorable weather conditions) the total for the area was 193. The aerial count for this area was 166. These figures indicate that the aerial count is usually as reliable as the dory counts. From the best boat counts (total 193) and the aerial count (total 166) a correction factor of 1.163 was obtained. When this is applied to the total Amchitka aerial count (1,560) the corrected count becomes 1,814. Treated similarly, the total outer Aleutian aerial count (9,507) becomes 11,057.

Shore counts compared with aerial counts

In a sample area, Kirilof Point, having a shoreline of approximately 3 nautical miles, five careful counts were made from the shore

during April and May. The high count was 62, the low 40, and the mean 51. On the aerial survey, 38 otters were recorded in the vicinity of Kirilof Point, about 30 of which would probably have been in view from the observation areas on land. In accordance with these data, a correction factor of about 1.7 should be applied to the aerial count, giving an estimated total of $(1,560 \times 1.7) = 2,652$ adult and subadult otters at Amchitka. If the correction factor is applied to the total otter count for the survey (9,507) the total becomes 16,162 otters.

Evaluation of counts

We have demonstrated that counts made from a dory and from an aircraft in a sample area at Amchitka may be similar and that shore counts in a sample area may reveal roughly twice the number of otters seen during an aerial count.

Variables and unknowns enter counting experiments, and these are difficult or impossible to evaluate:

1. The dory and shore counts were made over a period of 3 months. During this period, marked fluctuations in the number of otters in any given area were observed. Such fluctuations may occur daily in response to changing weather conditions. Therefore, we have no assurance that any of the counts used are comparable.

2. Weather conditions not only cause otters to move from exposed to sheltered areas but interfere with visibility. High winds reduce efficiency by (1) causing tears to flow in the observer's eyes, and (2) causing rough water that obscures the presence of otters. Precipitation blurs vision through optical instruments.

3. At 120 knots in an aircraft an area that may take days to cover from shore or in a dory is covered in 5 to 10 minutes. Thus the areas chosen for sample surface counts may have been too small. It was difficult to place figures correctly on charts during the aerial survey because the sample areas were covered so quickly.

4. Early sea otter hunters reported that otters were sometimes found up to 50 miles at sea. We have no information on how many otters may be at sea, that is, beyond the approximately 3/4- to 1-mile-wide strip of water surveyed around each island. Certainly the majority are within a quarter of a mile of shore or else concentrated near submerged offshore reefs.

For purposes of making rough calculations we may estimate that during a calm day at any given time approximately 50 percent of the otters in an area are resting on the sea's surface or on rocks and the other 50 percent are feeding. Food-diving otters may remain submerged for from 1 to 3 minutes and they remain for an approximately equal

period on the surface eating. Thus it is possible that at any given moment 75 percent of the otters in an area could be seen. In practice it is unlikely that this high a percentage would be seen.

After considering the sample counts in comparison with the aerial counts and in view of other considerations as presented above, it was concluded that for the purpose of obtaining an estimate of the population of sea otters in the outer Aleutians, between 50 percent and 75 percent of the otters were counted.

Results of the survey are presented graphically on the map on page iv.

Aerial counts and estimates of otter populations in the outer
Aleutian Islands, 19-27 May 1959

The following tabulation presents our aerial enumeration and estimates of the total number of otters in each area surveyed.

Date	Area	Otters counted	Estimate of total otters in area <u>1/</u>		
	<u>Near Islands</u>				
19 May	Attu	0		0	
" "	Aggattu	0		0	
" "	Alaid	0		0	
" "	Nizki	0		0	
" "	Shemya	<u>0</u>		<u>0</u>	
Total		0		0	
	<u>Rat Islands</u>				
19 May	Buldir	0		0	
" "	Kiska	894	1,192	-	1,788
" "	Little Kiska	83	111	-	166
" "	Tanadak and Tanadak Pass	150	200	-	300
" "	Segula	47	63	-	94
" "	Pyramid-Davidof	33	44	-	66
" "	Little Sitkin	50	66	-	100
" "	Rat	270	360	-	540
" "	Amchitka	1,560	2,078	-	3,120
" "	Semisopochnoi	<u>393</u>	<u>524</u>	-	<u>786</u>
Total		3,480	4,638	-	6,960
	<u>Delarof Islands</u>				
26 May	Garelloi	41	55	-	82
" "	Unalga	51	68	-	102
" "	Kavalga	275	367	-	550
" "	Ogliuga	112	149	-	224
" "	Skugul-Tag-Ugidak	281	375	-	562
" "	Gramp Rock	134	179	-	268
" "	Ilak	49	65	-	98
" "	Ulak	352	469	-	704
" "	Amatignak	<u>102</u>	<u>136</u>	-	<u>204</u>
Total		1,397	1,863		2,794

1/ Considering that 25 to 50 percent of the otters were not seen.

Date	Area	Otters counted	Estimate of total otters in area <u>1/</u>		
<u>Andreanof Islands</u>					
25-26 May	Tanaga	902	1,203	-	1,804
26 "	Bobrof	57	76	-	114
25-26 "	Kanaga	1,822	2,429	-	3,644
24-25 "	Adak	1,718	2,291	-	3,436
27 "	Kagalaska	1	1	-	2
" "	Little Tanaga	0	0	-	0
(Tana Bight to Comm. on N. side not covered, ca. 1/10 of island) <u>2/</u>					
27 "	Umak	0	0	-	0
(N. side, Cape Ruin to Cape Chakik not covered) <u>2/</u>					
27 "	Anagaksik	0	0	-	0
" "	Tagadak & Kanu	0	0	-	0
(about 50% covered)					
" "	Greater Sitkin	0	0	-	0
" "	Igitkin (South side only)	0	0	-	0
26 "	Chugul (" ")	0	0	-	0
" "	Tagalak (" ")	0	0	-	0
" "	Fenimore Rock, Ikiginak	0	0	-	0
" "	Oglodak (S.side only)	0	0	-	0
26-27 "	Atka	33	44	-	66
27 "	Kasatochi	0	0	-	0
" "	Koniuji	0	0	-	0
26-27 "	Amlia	83	111	-	166
27 "	Sagigik, Tonadak	0	0	-	0
" "	Agligidak	<u>0</u>	<u>0</u>	-	<u>0</u>
Total		4,616	6,155		9,232

1/ Considering that 25 to 50 percent of the otters were not seen.

2/ These areas covered in naval aircraft in January 1959; no otters seen.

Date	Area	Otters counted	Estimate of total otters in area ^{1/}		
27 May	Seguam	14	19	-	28
" "	Amukta	0	0	-	0
" "	Chagulak	0	0	-	0
" "	Yunaska	<u>0</u>	<u>0</u>	<u>-</u>	<u>0</u>
Total		14	19	-	28
<u>Islands of the Four Mountains</u>					
27 May	Herbert	0	0	-	0
Total all areas		9,507	12,665	-	19,014

^{1/} Considering that 25 to 50 percent of the otters were not seen.

SURVEYS IN OTHER ALASKAN AREAS BEFORE 1959

Between 6 May and 28 September 1957, Calvin J. Lensink, then a graduate student at Purdue University and a temporary employee of the Fish and Wildlife Service, conducted a sea otter population survey which included Kodiak Island, the south coast of the Alaska Peninsula, its offshore islands, and limited areas among the easternmost Aleutians. In addition, Lensink made shore counts at Amchitka in 1956, and dory and partial aerial counts at Adak and Kanaga in 1957. He was assisted by a number of Fish and Wildlife Service employees. Using his field counts and miscellaneous counts and estimates from many sources, which cover a period of many years, he presented population estimates of 31,850 to 49,750 sea otters in all areas of Alaska. Of this total, the majority (24,825 to 40,950) were considered to be in the Rat, Delarof, and Andreanof Island groups from which only fragmentary information of recent origin was available.*

We feel that Lensink's population estimates for the areas which he surveyed with care in 1957 are adequate. However, the results of our 1959 surveys indicate to us that for the areas which he did not survey his estimates were optimistic. It has been shown that calculations of marine mammal populations based on other than carefully gathered current field data are liable to be in considerable error (Kenyon et al., 1953).

The most apparent conflict between the basic information gathered by Lensink in 1956 and that gathered during our 1959 aerial surveys is

* Lensink, C. J.: Report on sea otter surveys, 6 May to 28 September 1957. U.S. Dept. Interior, Fish and Wildlife Service, Report submitted 4 April 1958, 61 p.

in the counts made at Amchitka. Lensink's shore counts totaled 2,903 otters for extensive, but not complete, shoreline counts. His estimate of the total Amchitka otter population based on these counts is 6,000 to 8,000 otters. Our total count was 1,560 otters for all of Amchitka, and our estimate of the total number of otters there is 2,078 to 3,120.

We believe that the following points clarify the differences in both counts and estimates:

1. Lensink's 1956 counts were made over a period of many weeks in the late summer and early fall during which frequent changes in weather took place. It has been shown that movements of otters along the coast take place in response to changing weather and are perhaps influenced by seasonal changes that affect food resources. The possibility is therefore suggested that otters which moved to different areas could have been counted more than once during the survey period.

2. In late summer and fall, more otters (older than pups accompanying their mothers) would be present than in the spring, shortly after the period (March and April) of considerable mortality.

3. The 1959 aerial survey showed that about twice as many otters were distributed around the eastern half of Amchitka as around the more precipitous western half of the island. An aerial survey, inadequate because of weather, in December 1957 revealed a similar pattern of distribution. The concentration of Lensink's shore counts on the eastern half of Amchitka would have the effect of inflating his estimate for the entire island.

4. It is possible that because of the sustained high otter population at Amchitka over a considerable period, with attendant food shortages, the population has actually been somewhat reduced recently.

As a result of all field work to date we believe that, if all adults, subadults, and pups are considered, the current otter population at Amchitka would not greatly exceed 4,000 individuals at the end of summer.

ESTIMATES OF THE TOTAL NUMBER OF SEA OTTERS IN ALASKA IN 1959

As stated in the foregoing section, we believe Mr. Lensink's population estimates for Alaska, other than the areas referred to, are adequate. In addition, Mr. Lensink (now of the Alaska Department of Fish and Game) told us that his recent (1959) observations in the Prince William Sound area confirmed his previous estimates (Lensink, 1958). Therefore the following summary is presented:

Survey date	Area	Field counts and estimates of sea otters	Estimates of total
19-27 May 1959	Aleutian Islands Attu Island to the Islands of Four Mountains	9,507	12,665 - 19,014
6 May - 28 Sept. 1957	Prince William Sound Kodiak-Afognak Alaska Peninsula Fox Islands	495 - 530 583 3,524 795	1,000 - 2,000 750 - 1,500 3,900 - 4,950 1,100 - 1,500
Total		14,904-14,939	19,415 -28,964
Round total			20,000 -30,000

Areas in need of further study are, the Islands of Four Mountains, Fox Islands, Alaska Peninsula, Sandman Reefs, and Shumagin Islands.

SUMMARY AND CONCLUSIONS

1. The 1959 aerial survey (19-27 May) of the outer Aleutians was successful in revealing sea otter distribution and the size of sea otter populations. Favorable weather during the observation period contributed in large degree to the confidence we place in our observations. A total of 9,507 adult and subadult otters were counted. The estimated total population (excluding pups) in the survey area is 13,000 to 20,000 otters.

2. The FWS R4D was found to be highly adequate for making sea otter surveys in the remote Aleutian area.

3. Counts made from a boat and from the shore in sample areas at Amchitka furnished data that confirmed the aircraft counts and furnished approximate limits for estimating the total population from aerial counts, that is, 50 to 75 percent of the otters present in survey areas were seen.

4. The areas of heaviest sea otter population are (a) western Andreanof Islands (Tanaga, Kanaga, Adak), 4,499 counted; (2) Rat Islands, 3,480 counted; (c) Delarof Islands, 1,397 counted.

5. Otters were not seen and are considered as absent or extremely scarce in (a) the Near Islands; (b) the central Andreanof Islands; (c) from Amukta Island to Herbert Island, inclusive, and probably in the

remainder of the Islands of Four Mountains which have not been surveyed.

6. Estimates based on 1956-57 sample counts, several older counts, and extrapolation of these various figures had placed the otter population in Alaska at from 32,000 to 50,000 animals. Estimates for all of Alaska based on the best up-to-date surveys now available place the figures at 20,000 to 30,000 otters. After certain areas, still inadequately surveyed, have been studied the estimate might be raised slightly.

7. Studies of population dynamics and movements of sea otters, primarily by aircraft observation, supplemented by shore and boat counts and shore-based detailed studies, should be continued.

PART II

SEA OTTER TRANSPLANT FROM AMCHITKA ISLAND TO THE PRIBILOFS IN 1959

The purposes of this report are (1) to summarize attempts to hold sea otters in captivity and to transplant them, (2) to give information about the requirements of captive sea otters while awaiting transplant, and their requirements during transportation if they are to be liberated in condition to survive, (3) to give an account of the successful 1959 transplant to the Pribilof Islands, and (4) to discuss the possibility of future transplants.

HISTORY OF TRANSPLANT ATTEMPTS

Period 1950 to 1955

The first transplant of sea otters was to have taken place in the winter of 1950-51. Refuge Manager Robert D. Jones of the Aleutian Islands National Wildlife Refuge and a crew of men went to Amchitka Island aboard the Fish and Wildlife Service vessel Brown Bear. A camp was established at Crown Reefer Point and in March 1951 at least 35 otters were captured on tidal rocks. An attempt to hold these animals in shallow mud-bottomed lakes was unsuccessful. All died within a few hours or a few days after capture.

In February 1954, Drs. Donald Stullken and Charles M. Kirkpatrick in company with Fish and Wildlife Service employees visited Amchitka. Considerable information about the physiology of sea otters and their behavior in captivity was obtained (Stullken and Kirkpatrick, 1955; Kirkpatrick et al., 1955). Otters were kept experimentally in two ways: (1) in a large wooden tank of water (fig. 1) and, (2) in an abandoned house where dry grass was used as bedding. All animals placed in the tank showed symptoms of shock and exposure and died within a few hours or a few days. Of those kept on dry bedding, three survived and were brought to Seattle in June 1954. Subsequently, when shipped to the National Zoological Park in Washington, D. C., and placed in a small inside pool, all died within a week.

Between 28 March and 4 April 1955, 31 otters were captured on Amchitka. On 9 April the 19 survivors were liberated at Otter Island in the Pribilof group. Three succumbed within a few minutes after being placed in cold water among ice floes. These otters had been carried from Amchitka to the Pribilofs aboard the chartered fishing vessel Paragon and were bedded on straw (fig.2) during the trip. Their fur became matted with filth, and when liberated each animal left a dirty brown trail in the water. Three of these near death were recaptured and were found to be soaked to the skin and rigid with cold.

None of the animals liberated at Otter Island was subsequently seen at the Pribilofs, and it is quite certain that none survived.

Period 1955 to 1959

The present program of sea otter studies began on 26 July 1955 when Kenyon and one Aleut laborer, Antone Bezezekoff, went to Amchitka Island, where they remained until 5 October. During this period, otters were held experimentally in cages without water for bathing (fig. 3), since the 1954 studies had indicated that this method was the most successful. A female otter, "Suzy," now approximately 5 years old (January 1960) was brought to Seattle and continues to live in good health there. The experience of 1955 indicated that bathing water was a necessity. The pelage of animals held for more than a month in dry bedding became severely worn and matted. The fact that the otter which survives in Seattle has done well in a pool demonstrates the need for access both to clean water and to dry areas.

In the early spring of 1956, Refuge Manager Jones, with Navy assistance, transplanted five otters via ship from Amchitka to Attu in the Near Islands. No otters were subsequently seen there.

Between 5 May and 26 July 1956, two experimental enclosures with pools were built on Amchitka. One of these was inside an abandoned building (fig. 4). Considerable humidity developed, and the fur of otters did not dry properly. All animals held here developed enteritis and died within 2 or 3 weeks. Therefore, an outdoor enclosure was built containing a bathing trough through which sea water was pumped for 3 to 4 hours each day (fig. 5). In both these enclosures otters were given only intermittent access to water, and the condition of their fur deteriorated. In addition, animals kept with only limited access to water frequently developed infections of the paws and flippers which, in combination with eventual wetting of the fur, contributed to the mortality. Although survival was improved under these conditions it was evident that caging methods were still inadequate.

As a result of the foregoing experiences and during the 1957 Amchitka field study (10 October to 11 December) a cement pool 15 feet long, 8 feet wide, and 4 feet deep was built. Surrounding the pool was a 7-foot-wide wooden platform, and the entire installation was surrounded by a 7-foot board fence (fig. 6). The enclosure was unroofed. A continuous flow of water was furnished by a fresh-water stream. All healthy animals placed in this enclosure remained healthy and several which were captured in poor condition regained health.

Dr. Kenneth L. Binkley, Veterinarian of the Woodland Park Zoo, Seattle, spent October 1957 with Fish and Wildlife Service employees on Amchitka. Experiments with antibiotics (for enteritis and infections of extremities), vermifuges, and tranquilizers were conducted. The most valuable finding was that promazine hydrochloride ("Sparine" Wyeth) could

be used to advantage in speeding the adjustment of nervous otters to captivity. Mother otters would have drowned their small pups during the initial period of anxiety after being placed in the pool if a tranquilizer had not been used. Within 5 minutes after an intramuscular injection of Sparine (1 mg. per pound of body weight) the mothers lost all fear, tended their pups, and ate normally. The effects of the drug wore off in approximately 18 to 24 hours but normal behavior continued. No harmful side effects were observed.

In December of 1957 an attempt was made to transplant eight otters via Reeve Aleutian Airways from Amchitka to St. Paul Island, Pribilof Islands Reservation. The animals were in excellent condition when they departed Amchitka. However, a storm caused delay, and unsatisfactory conditions inherent in an unpressurized, heated, passenger-carrying aircraft caused rapid deterioration and resulted in the death of six animals. The two survivors were taken to Seattle.

THE PROBLEMS OF HOLDING SEA OTTERS IN CAPTIVITY

Fur cleanliness

The sea otter has become adjusted to habitat conditions to which it is limited by specialized development of pelage, body form, habits and behavior. If it is to be held successfully in captivity its wild environment must be simulated in essential respects. It should be pointed out that weather and sea conditions at Amchitka prevent the construction of an enclosure in the sea, near shore, as was done by Russian biologists (May 1943; Barabash-Nikiforov, 1947). The basic reason for the failure of early survival experiments is now obvious. Under normal conditions in the wild, the fur of the sea otter is water-repellent. The skin is never wet but is protected by a blanket of air trapped in the fur fibers. The waterproof quality of the delicate fur was lost when animals were improperly held, as discussed above. Chilling, resulting from saturation of the fur, was followed by pathological conditions, usually enteritis, and shortly by death.

When otters were kept in shallow lakes (1951), mud and detritus undoubtedly became entangled in fur fibers, admitting water to the skin. In the large wooden tank (1954), an insufficient flow of water allowed an accumulation of suspended food and fecal matter to accumulate and become imbedded in the fur. Also there was not enough space for the otters to get out of the water. The same results were encountered as in the lake. When otters were given intermittent access to water (1956), food scraps and slime became imbedded in the fur during periods when water was not available. The progress of deterioration of waterproofness was less rapid under the latter conditions because a certain degree of cleansing was possible. In addition, inside caging as mentioned above with an adequate circulation of outdoor air hindered the drying of fur.

Even in the present outdoor pool, built in 1957, care must be taken to limit the number of otters held. If more than five are held

simultaneously, the pool must be drained daily or an accumulation of food scraps and feces begins to affect the water-repellent qualities of the fur. Captive otters are not affected adversely by frigid temperatures (fig. 7).

When bathing water is withheld, otters may be kept in clean dry litter for periods of several months. However, upon reintroduction to water the animals immediately become soaked to the skin, shiver, and show distress. With special care, until waterproofness is regained, such captives survive this ordeal. The other harmful effects of dry caging, fur wear, and matting probably cannot be remedied.

Food and parasitism

In addition to the problem of fur condition, the matter of proper feeding posed problems. Otters held under dry caging conditions were temperamental in feeding. Certain foods were refused entirely, even by hungry animals. Also, the fringed greenling, Lebius superciliosus, which is the most readily available large source of food at Amchitka, is heavily parasitized by the roundworm, Porrocaecum decipiens. At least two captives died in which peritonitis had been caused by the penetration of the gut by the larval stage of this roundworm. Other individuals, heavily infested after several weeks of captivity, often vomited and showed a loss of strength and vigor. It was found that freezing fish for 24 hours at temperatures between 0° and -15° F. eliminated this source of trouble. For this reason a freezer was placed in the otter enclosure in 1957. The minimum daily requirement of food for adult and subadult otters is 6 pounds of fish, but a daily offering of 8 pounds or more is desirable.

Because of the difficulty of obtaining a sustained supply of food in the quantity required by otters held on Amchitka, canned and dried foods (mink food and dog food) were given to captive otters. All such foods were either refused entirely or accepted in insignificant quantity. These foods also fall apart and are lost when placed in water.

Transportation

It can be inferred from the above that the transportation of otters poses severe problems if the animals are to be liberated in condition to survive. During air transportation it is impossible to furnish conditions comparable to those found in the wild. Animals must be shipped in small cages. Fur soiling may reach a dangerous point within 3 to 4 hours unless special attention is given. If the otters are fed slimy food or allowed to soil their fur with urine and fecal matter, waterproofness is rapidly lost and wetting to the skin results when the otter is placed in water. In a dry cage, temperature also becomes a critical problem. Animals experimentally flown by commercial airliner in 1957 failed to survive, it is thought, because of three factors: (1) high cabin temperatures (70° or more), (2) rapid ascent to altitudes above 10,000 feet in unpressurized aircraft, and (3) delays en route. If otters are transported aboard ship it would

be possible to build an enclosure which would include running water and access to dry areas. This would be expensive and has not been attempted. Otters were brought to Seattle in dry cages aboard ship and by air. These animals became soaked to the skin immediately on entering the water and only survived because of warm weather in Seattle or painstaking care by zoo employees and biologists who dried and warmed the animals, in some cases with towels, shredded paper, and electric heaters.

TRANSPLANT IN 1959

In view of the experiences outlined above, an experimental pilot transplant was planned for 1959. The most important aspects of this experiment were: (1) Subadult otters would be captured and held for an adjustment period of approximately 2 weeks before transport time. (2) They would be flown direct from Amchitka to St. Paul Island, eliminating the need for feeding while in transit. (3) Temperatures in the aircraft would be kept below 50°, and the aircraft would maintain an altitude of about 2,000 feet. (4) Specially constructed cages with raised floors of wire mesh would be used to prevent soiling the fur by feces and urine. These conditions were all met, and the transplant was accomplished successfully as recounted below.

From 6 to 8 May, during a severe storm, 10 subadult otters were captured and placed in the pool enclosure. Three animals died because they were in weakened condition when captured. Furthermore, the Amchitka pool was too small for 10 otters. Unless the animals are healthy when captured their chance of survival is reduced by crowding and competition for food. Therefore, when animals died they were not replaced.

On 20 May, seven otters, four females and three males, approximately 1 year old, weighing 26 to 36 pounds and bearing numbered Monel-metal tags on the hind flipper^{1/}, were taken to St. Paul Island by direct flight, at or below 2,000 feet altitude, on the Fish and Wildlife R4D plane (fig. 8). During flight, when the animals became excited they were given drinking water directly from a bottle, and their fur was sprinkled with water to help control temperature. Even at a cabin temperature of 48° - 49° F. restless animals exhibited distress from overheating before water was used. The animals were liberated near a reef at Polovina Point within 20 minutes after landing. All appeared in excellent condition and, except for one, each accepted and ate a fish as it swam from shore. When liberated the animals scattered.

On 21 May, Dave Spencer and Karl Kenyon watched one otter for some time from the cliffs of Reef Rookery (3 miles from the point of release). This animal was eating a large sea urchin and appeared contented and in

^{1/} Tag numbers, females: EL 432, EL 435, EL 438, and EL 12921; males: EL 428, EL 437, and EL 443.

good health. A brief aerial survey of a part of the west and south sides of St. Paul was made after take-off on 21 May. Two additional otters were seen at this time; however, several thousand fur seals in the area made it difficult to distinguish otters. Flight time from Amchitka to St. Paul was 4.3 hours.

Subsequent reports indicate that this transplant was successful. On 29 May we received a report that two otters were seen about 1 mile from the point of liberation and that one or two others were frequently seen near the village landing. On 21 August a party of Aleut fishermen who visited Otter Island, about 4 miles southwest of St. Paul, reported that they saw five otters in that area.

It is entirely possible that seven otters is too small a group to reestablish the species at the Pribilofs. No conclusions can be drawn until more time has elapsed.

FUTURE TRANSPLANTS

It has been demonstrated that the transplanting of sea otters is feasible. Recent population and distribution surveys indicate that several apparently suitable areas are not populated by the sea otter. These areas are: (1) the Near Islands; (2) the central Andreanof Islands (those islands between Adak and Atka); (3) Amukta, Chagulak, and Yunaska, and probably the Islands of the Four Mountains. Of these areas, we believe that transplants to the Near Islands, where aircraft facilities exist, would be most practical. The central Andreanof area, although having few if any otters, is bordered on the west by Adak where sea otters are now numerous and on the east by Atka where a small population exists. A transplant to this area would be impractical, since natural repopulation will take place if habitat conditions are favorable. Distances between islands are short and quite within the range of otter movement.

The southeastern Alaska area has been suggested as one to which otters should be transplanted. We believe this area should not be considered for transplant for the following reasons: (1) The population of otters in the Prince William Sound area may spread naturally southward along the coast. Scattered but unconfirmed reports of sea otters suggest that some have already moved into this area. (2) Human populations and fishing activities in southeastern Alaska would greatly decrease the chance that transplanted otters would survive. Fishermen often shoot at any animal they see. Few would recognize a sea otter. (3) The area is extremely large and islands are close together. A very considerable number of sea otters would have to be moved if any results were to be obtained in the foreseeable future. If the otters scattered on release it is entirely possible that no breeding would take place. (4) The area is at least 1,600 nautical miles from an area (Amchitka) where otters can easily be obtained. It would be difficult to bring a suitable number of animals this distance in condition for survival in the wild.

The otter population at Adak has increased greatly during the past few years. None was seen there on a survey by Refuge Manager Jones in the late 1940's, but in our 1959 survey 1,718 were counted. This indicates that otters have moved to the Adak area from the large Kanaga population across 6 miles or more of open water. Now that sea otter populations in various areas are quite substantial, it is probable that new island populations will become established more rapidly than during past years.

If additional transplants to St. Paul Island or the Near Islands are contemplated, we believe that they could be accomplished most practically in a similar manner and at the same season as in 1959.

SUMMARY AND CONCLUSIONS

1. Sea otters were not successfully transplanted before 1959 because their requirements in captivity and during transportation were not met.

2. The primary reason for the death of captive sea otters was that foreign matter became imbedded in the fur, causing the animals to become wet to the skin. Chilling was followed by pathological symptoms, usually enteritis, and death in a few hours or days in all such cases.

3. Otters may now be held successfully in captivity. The requirements are: (a) an abundant supply of clean running water (either fresh or salt), (b) an abundant supply of parasite-free food, (c) free access to both water and clean dry areas, and (d) free circulation of air.

4. If otters are to be liberated at the place of transplant in condition to survive they must be: (a) shipped direct by air, (b) carried in cages having a false bottom to eliminate soiling of fur by urine and feces, (c) not fed during shipment (to avoid soiling fur), (d) kept at aircraft cabin temperatures below 50° F. (even at 50°, sufficient water must be available for drinking and to wet the fur of excited and restless animals that become overheated), (e) kept below 10,000 feet (about 2,000 feet was satisfactory) in unpressurized aircraft and not carried aloft at a rapid rate of ascent, (f) liberated immediately on arrival at destination, and (g) if carried aboard ship, the conditions outlined under point 3 above must be met.

5. Promazine hydrochloride ("Sparine" Wyeth) is a useful tranquilizer to speed the adjustment to captivity of nervous sea otters. No harmful side effects have been noted.

6. A transplant of seven subadult sea otters on 20 May 1959 from Amchitka Island in the Aleutians to St. Paul Island in the Pribilofs, a distance of approximately 500 miles was accomplished successfully when all conditions outlined under points 3 and 4 were met. An

observation at Otter Island (5 miles from the point of liberation) of five otters on 21 August 1959 indicated that this transplant was successful. Previous attempts at transplant (1950-57) failed because the specified conditions were not met.

7. Aside from the Pribilofs, the most practical place for future transplants is the Near Island group, particularly Attu and Shemya where aircraft facilities exist and where no otters have been observed. Transplants to other areas are not advisable at the present time.

8. It cannot now be said with certainty whether otters can be transplanted by ship. If proper facilities were built on board, we believe that transplanting by ship might be successful. This method would be far more expensive than transplant by air.

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APPENDIX A -- DORY AND AERIAL COUNTS OF A SAMPLE AREA AT AMCHITKA
ISLAND, 1959

Date	Area covered							Dory counts
26 Feb.	Constantine Harbor to Ivakin Point, direct ^{1/}							21
" "	"	"	"	"	"	"	"	14
2 Mar.	"	"	"	"	"	"	"	<u>12</u>
Total								47
Average								15.7= 16 rounded
26 Feb.	Ivakin Point to East Cape (excluding East Cape), direct							17
2 Mar.	"	"	"	"	"	"	"	<u>31</u>
Total								48
Average								24
26 Feb.	At East Cape							60
2 Mar.	"	"	"	"	"	"	"	<u>16</u>
Total								76
Average								38
27 Feb.	Constantine Harbor to Crown Reefer Point, direct							7
10 Mar.	"	"	"	"	"	"	"	33
" "	"	"	"	"	"	"	"	13
23 Apr.	"	"	"	"	"	"	"	13
" "	"	"	"	"	"	"	"	<u>24</u>
Total								90
Average								18
27 Feb.	Constantine Harbor to Crown Reefer Point, shoreline							66
27 Feb.	At Crown Reefer Point							12
10 Mar.	"	"	"	"	"	"	"	12
23 Apr.	"	"	"	"	"	"	"	<u>25</u>
Total								49
Average								16
2 Mar.	Constantine Harbor to Ivakin Point, shoreline							57

^{1/} Direct indicates offshore areas, as opposed to those counts made very close to the shore.

Date	Area covered	Dory counts	
26 Feb.	Ivakin Point to East Cape, shoreline	62	
2 Mar.	" " " " " "	<u>52</u>	
Total		114	
Average		57	
<u>Summary, average surface counts</u>		<u>Dory counts</u>	<u>Aerial counts</u>
Constantine Harbor to Ivakin Point, direct (average of 3 counts)		16	
Constantine Harbor to Ivakin Point, shoreline (1 count)		57	60
Ivakin Point to East Cape, direct (aver. 2 counts)		24	
" " " " " shoreline (" " ")		<u>57</u>	<u>26</u>
Total		154	86
Constantine Harbor to Crown Reefer Point, direct (average 5 counts)		18	
Constantine Harbor to Crown Reefer Point, shoreline (1 count)		<u>66</u>	85
Total		84	
Grand total		238	
At East Cape (average 2 counts)		38	150
At Crown Reefer Point (average 3 counts)		16	21
Total for 13.5 miles coastline, including Crown Reefer Point and East Cape		292	342

APPENDIX B -- SAMPLE SHORE AND DORY COUNTS EXTENDED TO ALL OF AMCHITKA

Shore counts were most frequently and carefully made along the 3-mile coastline of Kirilof Point. The mean of five counts made in January, February, and March is 20 (extremes 16 and 26). If the mean is applied to the 120 miles of shoreline, the total estimate from Amchitka becomes approximately 800 otters. The mean of five shore counts made in April and May is 51 (extremes 40 and 62). The mean applied to the 120-mile shoreline gives an estimate of 2,040 otters for all of Amchitka.

The purpose of including this information is to demonstrate that such sample shore counts must be evaluated with considerable care and in the light of many other observations.

These shore counts demonstrate that movements of otters in response to weather and food availability may introduce considerable variability in the results of such counts.

Since otters tend to concentrate around points, care must be taken when generalizing on the basis of sample shore counts.

The average of individual counts, made on 4 days of counting otters from the dory, have been combined (Appendix A). The total obtained in this way from (and including) East Cape to (and including) Crown Reefer Point is 292. When this 13.5-mile stretch is considered a sample area and applied to the air survey track distance around Amchitka of 82 miles^{1/}, the estimated otter population becomes 1,772. This figure is surprisingly close to our total aerial count of 1,560 otters.

Excluding East Cape and Crown Reefer Point (areas of otter concentration) from dory counts and using 12.5 miles of coastline for the counted sample, then 238 otters are included. Applying this figure

^{1/} At our request the U. S. Coast and Geodetic Survey office in Seattle measured the highly irregular shoreline of Amchitka and gave us the approximate distance of 120 nautical miles. For the present purpose, however, distances are measured along the track of the surveying aircraft over the water. By using this method the distance around Amchitka is 82 nautical miles. For the purpose of applying corrections obtained from sample dory surveys to aerial counts this method of distance measurement is more satisfactory. Inaccuracies in distance measurements of sample coastal areas caused by the extremely irregular coastline of Amchitka are otherwise difficult to evaluate.

to the total Amchitka coastal strip of 82 miles gives a total population estimate of 1,561 otters at Amchitka -- a surprising coincidence.

It is axiomatic that not all otters could have been seen on any count. The similarity of the aerial and surface counts in the sample area must not therefore be regarded as proof that these counts exactly represent the number of otters in this area. However, we believe that because of the care that was exercised in making all counts, we now have a reasonable representation of the order of magnitude of otters found in the areas surveyed.



Figure 1.--Attempts to hold sea otters in this tank in 1954 were unsuccessful. An insufficient flow of water allowed food scraps and fecal matter to accumulate, causing fur to lose waterproof qualities. Also, insufficient space was provided for otters to get out of the water. Otters survived in this environment only a few hours. (KWK 59-9-6)



Figure 2.--Otters held on dry litter habitually lay on their backs while eating, allowing food slime and scraps to soil their fur. When again permitted to enter water they became soaked to the skin and suffered severe chilling. Animals shown here, when liberated at the Pribilofs in 1955, soon succumbed to exposure. (KWK 55-5-1)



Figure 3.--Young otters were held experimentally on wire mesh and trained to eat from pans. In spite of daily washing by hand their fur became severely worn and matted. (KWK 55-18-3)



Figure 4. In 1956 this pool was constructed in an old building. Water was supplied for several hours daily. Eventual fur soiling and lack of sufficient free air circulation prevented proper drying of fur. Animals survived for 2 to 3 weeks in this enclosure but all eventually died. (KWK 56-12-28)

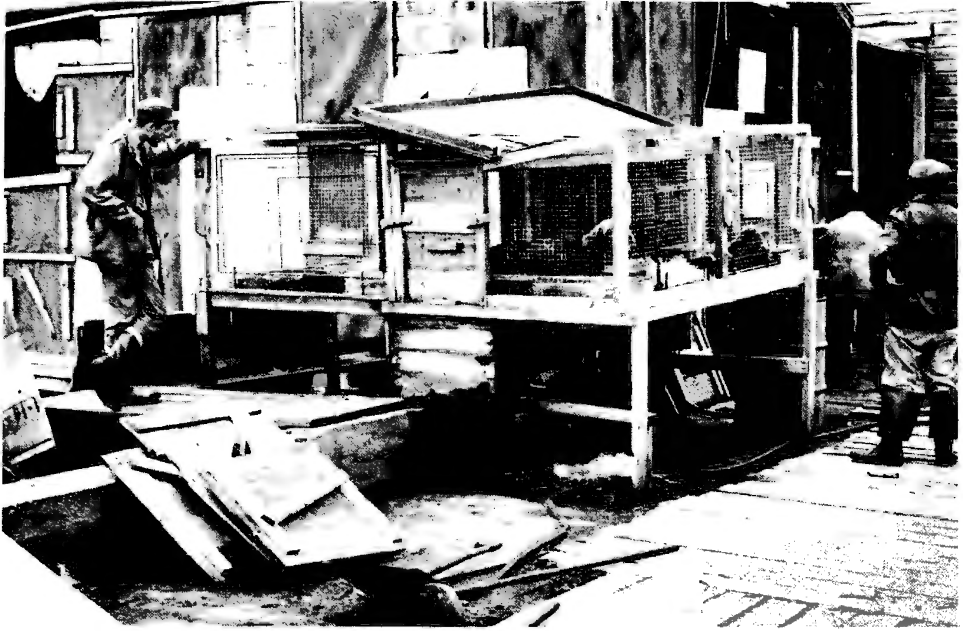


Figure 5.--In 1956 this outdoor cage was built around a bathing trough and sea water was pumped into it for several hours daily. Fur condition deteriorated in about 3 weeks and with frequent infections of extremities few animals survived more than a month. (KWK 56-17-36)



Figure 6.--In 1957 this enclosure, including a pool, a continuous supply of fresh running water, and clean dry areas, was built. No difficulty is encountered in holding otters indefinitely under the conditions offered. (KWK 57-27-12)



Figure 7.--Freezing weather, causing ice to cover the holding pool, necessitated frequent removal of ice to permit the otters access to open water. No ill effects resulted to otters as long as their fur remained clean and water-repellent. (KWK 59-3-1)



Figure 8.--Cages having false bottoms, one otter to each cage, were used to transplant seven otters from Amchitka to St. Paul Island on 20 May 1959. The R4D cabin temperature was held at 48° to 50° F. and otters were given only water during flight. All were liberated in excellent condition and survived. (KWK 59-15-13)